The only important group was No. 4781, the other two being very small and seen only on the one day.

No. 4781 was seen during three rotations—viz. September 3–15, September 30–October 12, and October 28–November 6. Its first appearance was at the east limb on September 3; its last appearance, on the disc, on November 6. It attained its greatest area during the present apparition, 1898 September 3–15.

Storm No. 19, 1903 *October* 31–November 1.—Preceded by a wave in Dec. and H.F. at October $30^d\ 21^h$, and then by small movements up to the time of the characteristic instantaneous movement.

Sun-spots on 1903 *October* $31^d{\cdot}426$.

Letter for Group.	Total Area. Projected.	Total Area. Corrected.	Heliographic Longitude.	Heliographic Latitude.	Longitude from C.M.
a.	1216	670	296°·0	−20°·0	− 5°·8
b.	520	698	232·0	+17·5	−69·8
Totals	1736	1368			

Group *a* appeared at the east limb on October 25, and reached the west limb November 6. The measures for October 31 are approximate only; not definitive.

Further Note on the "Great" Magnetic Storms, 1875–1903, *and their association with Sun-spots.* By E. Walter Maunder.

The facts brought out in the preceding paper are, so far as they go, in entire agreement with the facts tabulated in the important paper by the Rev. W. Sidgreaves read before the Society 1900 December 14. The difficulty is in their interpretation. It has been urged that if there be a real direct connexion between a particular great sun-spot and a great magnetic storm, then that connexion should always show itself. Every great spot on the Sun should be answered by a great magnetic storm here; every great magnetic storm should be synchronous with the appearance of some great spot; and, further, the violence of the storm should bear a definite relation to the extent of the spot. This relation does indeed hold good if we consider only the average of a number of instances; it does not hold good universally in every individual case.

An example is in the immediate recollection of everyone. The sun-spot which crossed the central meridian on 1903 October 12 was one of the six or seven largest groups seen during thirty years. The magnetic storm which occurred at this

time was an "active" one, not a "great" one. The sun-spot of October 31 was a large one, but not of extraordinary dimensions—less than one-third the size of that of October 12. Synchronous with its passage over the central meridian was the greatest magnetic storm that has been recorded for thirty years—perhaps the greatest that has yet been recorded at Greenwich. The natural expectation would have been that the reverse should have been the case, that the greater spot should have corresponded to the greater storm, and the smaller to the feebler one.

Yet such an expectation, however natural, involves a number of assumptions, for some of which we have very little warrant. It assumes, for example, that the efficiency of a spot is greatest at the moment of its attaining its greatest area. More important still, it assumes that its influence is equally great in all directions; that there is nothing like *direction* in the forces or emanations which proceed from that disturbed region of the Sun of which the spot is the visible indication. Yet this assumption is founded upon no sufficient evidence, even if it be not a wholly gratuitous one.

If we consider the solar corona we recognise at once that it is not symmetrically distributed round the Sun, evenly thinning out to exactly the same extent in all directions. On the contrary it is highly structured. Whatever conception we form of its nature, we are obliged to consider the lines which compose it as essentially lines of force: they indicate regions where action is greater than in the neighbouring darker areas. The eclipses of the last eight years have been specially instructive on this point. The corona of 1896, as photographed both by Sir George Baden-Powell's expedition to Nova Zembla and by MM. Kostinsky and Hansky of the Russian expedition, showed one great lobe whose outlines curved together till they united to form one long straight ray. In the eclipse of 1898 no fewer than four such synclinal regions were seen, one of which was triple, all of which terminated in straight rays of prodigious length. The longest was actually photographed for a distance from the Sun's centre which could not have been less than five millions of miles. In the two following eclipses, 1900 and 1901, the same features were perceived, though the long rays were not photographed to the same distance as in 1898; and there is no reason to doubt that they are features of every eclipse. That these extensions were not photographed before 1896 is no doubt due simply to the circumstance that a sufficient exposure and extent of field was not employed in order to secure them.

If we suppose that the effect of a solar disturbance travels outwards in somewhat the same manner as these long coronal rays—in other words, that the effect is greatest in some one direction which need not be truly radial, since the great coronal rays are not necessarily so—this will remove the ground of the difficulty before us. The intensity of any magnetic storm due to a solar disturbance would then depend upon two factors:

first, the actual magnitude of the disturbance itself, and next, upon the distance of the Earth from the direction of maximum effect. We should find, as we actually do, that when the average was taken of a large number of cases the frequency of magnetic storms and their intensity would correspond to the size of the solar spots; but at the same time we should also find, as we do, that there would be a wide margin of irregularity in special instances. It is in perfect accord with this suggestion that we actually find at the moment of commencement of the nineteen great storms examined that the most important spot on the Sun was always found within a restricted area on the surface. If the influence of the spot were exactly equal over the whole sphere of which it was the centre it is difficult to understand why this relation should have shown itself.

In the foregoing remarks I have confined myself entirely to the spots. We have at present no sufficient material for a similar discussion in the case of faculæ, prominences, or flocculi. In the ordinary way we see prominences only round the limb, faculæ only near it; of flocculi we have not yet enough observations; spots, on the other hand, we see wherever they exist in any part of the hemisphere turned towards us, and our knowledge of them may be said to be fairly complete. Further, the four different orders of phenomena are not independent, but interdependent; and concerning the first three we know that they go through their variations in the course of a solar cycle in substantial accord. At the present time, whatever may be the case in the future, spots are the most easily observed and most fully observed of all the various phenomena which can afford us any index of the solar activity.

Suggested Connection between Sun-spot Activity and the Secular Change in Magnetic Declination. By Mrs. Walter Maunder.

(*Communicated by E. Walter Maunder.*)

A connexion between the Sun and terrestrial magnetism has been recognised as existing in the following relations :—

(1) Daily.—The diurnal range of magnetic declination, dip, and intensity, according to the hours of local mean time, when by means of the Earth's rotation different parts of its surface are exposed to the action of the Sun's rays.

(2) Yearly.—The annual variation in the amount of the diurnal range corresponding to the variation in the presentation of any particular locality to the Sun's rays in the course of the year.

(3) Cyclical: "Eleven-year" Period.—Variation in the